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(71)Applicant : NTT POWER & BUILDING FACILITIES INC
(72)Inventor : TAKAGI SHINYA
MATSUSHIMA TOSHIO

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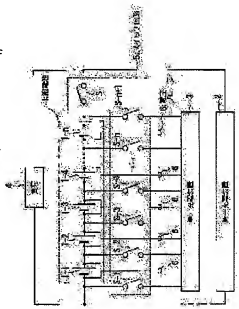
## (54) CHARGING DEVICE FOR LITHIUM ION SECONDARY CELL, AND CHARGING METHOD OF THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a charging device for a lithium ion secondary cell and charging method of the same which can efficiently charge a set of cells composed of a plurality of serially connected lithium ion secondary cells at low cost during stand-by in a state of float charging.
SOLUTION: The set of cell 1 is charged by a first charging device 2 with a constant current until some of lithium ion secondary cells 1-1 to 1-n get into a state of full charge. The charging by the first charging device 2 is stopped when one cell gets into a state of full charge. Afterwards, respective terminals of the lithium ion secondary cells 1-1 to 1-n are selected by a switch circuit 5 and every cells of the lithium ion secondary cells 1-1 to 1-n composing the set of cells are successively charged until they get into a sate of full charge while monitoring respective terminal voltage. By the above, respective lithium ion secondary cells 1-1 to 1-n composing the set of cells 1 are fully charged without overcharge, and the set of cells 1 is brought in a state of full charge.



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(71)出願人　593063161
株式会社エヌ・ティ・ティ　ファシリティーズ
東京都港区芝浦三丁目４番１号
(72)発明者　高木　晋也
東京都港区芝浦三丁目４番１号　株式会社エヌ・ティ・ティファシリティーズ内
(72)発明者　松島　敏雄
東京都港区芝浦三丁目４番１号　株式会社エヌ・ティ・ティファシリティーズ内
(74)代理人　100064908
弁理士　志賀　正武　（外６名）

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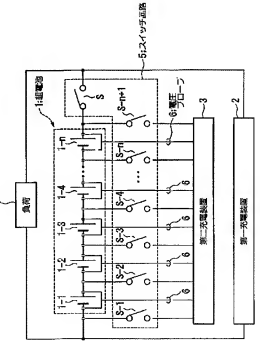
(54)【発明の名称】　リチウムイオン二次電池充電装置および方法

(57)【要約】
【課題】　直列接続された複数個のリチウムイオン二次電池からなる組電池を、フロート充電状態で待機している場合に、安価かつ効率的に充電することを可能とするリチウムイオン二次電池充電装置および方法を提供すること。
【解決手段】　第一充電装置２により、リチウムイオン二次電池１－１～１－ｎの何れかが満充電状態になるまで、組電池１を定電流により充電する。何れかが満充電状態になると、第一充電装置２による充電を停止する。そして、スイッチ回路５によりリチウムイオン二次電池１－１～１－ｎの各端子を選択し、各端子電圧をモニターしながら、組電池１をなすリチウムイオン二次電池１－１～１－ｎをセル毎に満充電状態に達するまで順次充電する。これにより、組電池１をなす各リチウムイオン二次電池を過充電とすることなく満充電状態とし、かつ組電池１を満充電状態とする。



【特許請求の範囲】
【請求項１】　直列接続された複数個のリチウムイオン二次電池からなる組電池を充電するための充電装置において、
前記組電池を充電する第一の充電装置と、
前記組電池をなす各リチウムイオン二次電池の端子を選択するためのスイッチ切替手段と、
前記スイッチ切替手段により選択された端子の電圧をモニターしながら前記組電池をなす複数個のリチウムイオン二次電池をセル毎に充電する第二の充電装置と、
を備えて構成されたことを特徴とするリチウムイオン二次電池充電装置。
【請求項２】　請求項１に記載されたリチウムイオン二次電池充電装置において、
前記第一の充電装置は、前記組電池をなす複数個のリチウムイオン二次電池のうちの何れか一つが満充電状態になるまで前記組電池を充電し、
前記第二の充電装置は、前記組電池をなす複数個のリチウムイオン二次電池のうちの何れか一つが満充電状態になった場合、前記複数個のリチウムイオン二次電池のうち、満充電状態に至っていない他のリチウムイオン二次電池を１セルずつ充電することを特徴とするリチウムイオン二次電池充電装置。
【請求項３】　直列接続された複数個のリチウムイオン二次電池からなる組電池であって互いに並列接続された第一および第二の組電池を充電するための充電装置において、
前記第一の組電池および第二の組電池を充電する第一の充電装置と、
前記第一の組電池をなす各リチウムイオン二次電池の端子を選択するための第一のスイッチ切替手段と、
前記第二の組電池をなす各リチウムイオン二次電池の端子を選択するための第二のスイッチ切替手段と、
前記第一のスイッチ切替手段により選択された端子の電圧をモニターしながら前記第一の組電池をなす複数個のリチウムイオン二次電池をセル毎に充電し、前記第二のスイッチ切替手段により選択された端子の電圧をモニターしながら前記第二の組電池をなす複数個のリチウムイオン二次電池をセル毎に充電する第二の充電装置と、
を備えて構成されたことを特徴とするリチウムイオン二次電池充電装置。
【請求項４】　直列接続された複数個のリチウムイオン二次電池からなる組電池を充電するための充電方法において、
（ａ）前記組電池をなす複数個のリチウムイオン二次電池のうちの何れか一つが満充電状態になるまで前記組電池を定電流で充電するステップと、
（ｂ）前記組電池をなす複数個のリチウムイオン二次電池のうちの何れか一つが満充電状態になった場合、前記複数個のリチウムイオン二次電池のうち、満充電状態に至っていない他のリチウムイオン二次電池を１セルずつ定電流で充電するステップと、
（ｃ）前記組電池をなす複数個のリチウムイオン二次電池をセル毎に充電した後に、前記組電池をフロート充電するステップと、
を含むことを特徴とするリチウムイオン二次電池充電方法。
【請求項５】　前記第一の充電装置が、
前記第二の充電装置により前記複数個のリチウムイオン二次電池が充電されたことによって前記組電池の端子電圧として現れる第一の電圧よりも低い第二の電圧で前記組電池をフロート充電することを特徴とする請求項１または２に記載されたリチウムイオン二次電池充電装置。
【請求項６】　前記第一の充電装置が、
前記第二の充電装置により前記第一および第二の組電池をなす複数個のリチウムイオン二次電池が充電されたことによって前記第一および第二の組電池の端子電圧として現れる第一の電圧よりも低い第二の電圧で前記第一および第二の組電池をフロート充電することを特徴とする請求項３に記載されたリチウムイオン二次電池充電装置。
【請求項７】　前記組電池をフロート充電するステップでは、
前記第二の充電装置により前記複数個のリチウムイオン二次電池が充電されたことによって前記組電池の端子電圧として現れる第一の電圧よりも低い第二の電圧で前記組電池をフロート充電することを特徴とする請求項４に記載されたリチウムイオン二次電池充電方法。
【請求項８】　前記組電池をなす複数のリチウムイオン二次電池の各端子電圧をモニターし、何れかの端子電圧が所定値にまで低下した場合、前記組電池の放電を停止させる手段を備えたことを特徴とする請求項１ないし３の何れか１項に記載されたリチウムイオン二次電池充電装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、リチウムイオン二次電池を充電するためのリチウムイオン二次電池充電装置および方法に関する。更に詳しくは、複数個のリチウムイオン二次電池が直列・並列状に接続された組電池内の各単セルの充電をバランス良く行う充電装置および方法に関するものであって、フロート充電により充電状態で待機して使用される組電池を、複雑な制御回路を使用しないで安価かつ効率的に充電する技術に関するものである。
【０００２】
【従来の技術】一般に、携帯電話機やコードレス電話機などの移動無線通信機をはじめ、ビデオカメラやノート型パソコンなどでは、体積エネルギー密度および重量エネルギー密度が高いリチウムイオン二次電池が多く使わ

れている。このリチウムイオン二次電池は、複数個を直列接続して組電池とされ、上記の電子機器の電源として使用されるのが通例である。

【0003】

【発明が解決しようとする課題】ところで、従来、リチウムイオン二次電池の充電方式として、単セル当たり４．１Ｖまたは４．２Ｖという一定値に充電完了電圧を設定し、電池電圧がこれらの充電完了電圧に到達するまでは一定電流値で充電し、充電完了電圧に達した後は、定電圧充電に移行する定電流・定電圧充電方式が採用されている。この方式によれば、ｎ個（ｎは任意の自然数）の直列接続されたリチウムイオン二次電池からなる組電池を充電する場合、例えば単セル当たりの充電完了電圧を４．１Ｖとすると、組電池の端子電圧がｎ×４．１Ｖになるまで、組電池に対して定電流充電を行うことになる。

【0004】しかしながら、セル間の端子電圧にアンバランスが存在すると、組電池の端子電圧がｎ×４．１Ｖに達する前に、いずれか一つのセルが充電完了電圧に達し、他のセルが充電完了電圧に達していない状態が起こる。このため、先に充電完了電圧に到達したセルに対して定電流充電が継続して行われ、このセルのリチウムイオン二次電池が過充電状態になるという問題がある。

【0005】この問題を更に説明する。直列接続された複数個のリチウムイオン二次電池からなる組電池をフロート充電方式で充電する場合、個々のリチウムイオン二次電池の容量や内部抵抗が常に同じであれば、全てのリチウムイオン二次電池をバランス良く充電できる。しかしながら、実際には、各リチウムイオン二次電池の容量や内部抵抗には若干のばらつきが存在する。また、初期において各リチウムイオン二次電池の内部抵抗が同じであったとしても、フロート充電により、時間の経過に伴って電池の内部特性が変化し、各リチウムイオン二次電池の容量や内部抵抗も変化する。その結果、各リチウムイオン二次電池の特性上のバランスが崩れ、組電池をなす特定のリチウムイオン二次電池が過充電状態になる。

【0006】また、組電池が満充電状態に達すると定電流充電が終了するが、特定のリチウムイオン二次電池が過充電状態になると、この組電池をなす他のリチウムイオン二次電池が満充電状態に達しない状態で充電が終了することになる。従って、これらのリチウムイオン二次電池が保有している能力を十分に活用できなくなるという問題もある。このように、従来の充電方式によれば、組電池をなす各リチウムイオン二次電池を満充電状態にまでバランスよく充電することができないという問題がある。

【0007】この発明は、上記事情に鑑みてなされたものであり、その目的とするところは、直列接続された複数個のリチウムイオン二次電池からなる組電池を、フロート充電状態で待機している場合に、安価かつ効率的に充電することを可能とするリチウムイオン二次電池充電装置および方法を提供することにある。

【0008】

【課題を解決するための手段】上記課題を解決するため、この発明は以下の構成を有する。請求項１に記載された発明に係るリチウムイオン二次電池充電装置は、直列接続された複数個のリチウムイオン二次電池からなる組電池を充電するための充電装置において、前記組電池を充電する第一の充電装置と、前記組電池をなす各リチウムイオン二次電池の端子を選択するためのスイッチ切替手段と、前記スイッチ切替手段により選択された端子の電圧をモニターしながら前記組電池をなす複数個のリチウムイオン二次電池をセル毎に充電する第二の充電装置と、を備えて構成されたことを特徴とする。

【0009】請求項２に記載された発明に係るリチウムイオン二次電池充電装置は、請求項１に記載されたリチウムイオン二次電池充電装置において、前記第一の充電装置が、前記組電池をなす複数個のリチウムイオン二次電池のうちの何れか一つが満充電状態になるまで前記組電池を充電し、前記第二の充電装置が、前記組電池をなす複数個のリチウムイオン二次電池のうちの何れか一つが満充電状態になった場合、前記複数個のリチウムイオン二次電池のうち、満充電状態に至っていない他のリチウムイオン二次電池を１セルずつ充電することを特徴とする。

【0010】請求項３に記載された発明に係るリチウムイオン二次電池充電装置は、直列接続された複数個のリチウムイオン二次電池からなる組電池であって互いに並列接続された第一および第二の組電池を充電するための充電装置において、前記第一の組電池および第二の組電池を充電する第一の充電装置と、前記第一の組電池をなす各リチウムイオン二次電池の端子を選択するための第一のスイッチ切替手段と、前記第二の組電池をなすリチウムイオン二次電池の端子を選択するための第二のスイッチ切替手段と、前記第一のスイッチ切替手段により選択された端子の電圧をモニターしながら前記第一の組電池をなす複数個のリチウムイオン二次電池をセル毎に充電し、前記第二のスイッチ切替手段により選択された端子の電圧をモニターしながら前記第二の組電池をなす複数個のリチウムイオン二次電池をセル毎に充電する第二の充電装置と、を備えて構成されたことを特徴とする。

【0011】請求項４に記載された発明に係るリチウムイオン二次電池充電方法は、直列接続された複数個のリチウムイオン二次電池からなる組電池を充電するための充電方法において、（ａ）前記組電池をなす複数個のリチウムイオン二次電池のうちの何れか一つが満充電状態になるまで前記組電池を定電流で充電するステップと、（ｂ）前記組電池をなす複数個のリチウムイオン二次電池のうちの何れか一つが満充電状態になった場合、前記

複数個のリチウムイオン二次電池のうち、満充電状態に至っていない他のリチウムイオン二次電池を１セルずつ定電流で充電するステップと、（ｃ）前記組電池をなす複数個のリチウムイオン二次電池をセル毎に充電した後に、前記組電池をフロート充電するステップと、を含むことを特徴とする。

【００１２】請求項５に記載された発明に係るリチウムイオン二次電池充電装置は、請求項１または２に記載されたリチウムイオン二次電池充電装置において、前記第一の充電装置が、前記第二の充電装置により前記複数個のリチウムイオン二次電池が充電されたことによって前記組電池の端子電圧として現れる第一の電圧よりも低い第二の電圧で前記組電池をフロート充電することを特徴とする。請求項６に記載された発明に係るリチウムイオン二次電池充電装置は、請求項３に記載されたリチウムイオン二次電池充電装置において、前記第一の充電装置が、前記第二の充電装置により前記第一および第二の組電池をなす複数個のリチウムイオン二次電池が充電されたことによって前記第一および第二の組電池の端子電圧として現れる第一の電圧よりも低い第二の電圧で前記第一および第二の組電池をフロート充電することを特徴とする。請求項７に記載された発明に係るリチウムイオン二次電池充電方法は、前記組電池をフロート充電するステップでは、請求項４に記載されたリチウムイオン二次電池充電方法において、前記第二の充電装置により前記複数個のリチウムイオン二次電池が充電されたことによって前記組電池の端子電圧として現れる第一の電圧よりも低い第二の電圧で前記組電池をフロート充電することを特徴とする。請求項８に記載された発明に係るリチウムイオン二次電池充電装置は、請求項１、２、３の何れか１項に記載されたリチウムイオン二次電池充電装置において、前記組電池をなす複数のリチウムイオン二次電池の各端子電圧をモニターし、何れかの端子電圧が所定値にまで低下した場合、前記組電池の放電を停止させる手段を備えたことを特徴とする。

【００１３】本発明の構成によれば、直列接続された複数個のリチウムイオン二次電池を充電する場合、第一の充電装置を適用していずれかの電池が充電完了電圧になるまで定電流で充電し、いずれかの電池が充電完了電圧に達した後は、組電池に接続した第一の充電装置を切り離し、単セルを充電可能な第二の充電装置を適用して充電完了電圧に達していない他の電池を順番に充電完了電圧まで充電する。

【００１４】

【発明の実施の形態】以下、本発明の実施形態を図面を参照して説明する。なお、この実施の形態において、「セル」なる用語は、組電池をなす各リチウムイオン二次電池を表すものとする。図１に、本実施の形態１に係るリチウムイオン二次電池充電装置の構成および適用例を示す。図１において、組電池１は、バックアップ用の電源として機能するものであって、直列接続された複数個のリチウムイオン二次電池１－１～１－ｎから構成され、非常時に負荷４に対し直流電力を供給するものである。以下の説明では、適宜、組電池１をなす複数のリチウムイオン二次電池１－１～１－ｎのそれぞれを「単セル」と称す。

【００１５】第一充電装置２は、組電池１をなすリチウムイオン二次電池１－１～１－ｎを同時的に充電するための充電手段であり、スイッチＳを介して組電池１に接続される。第二充電装置３は、組電池１の単セルを充電可能な程度の充電能力を有する小型の充電装置であって、スイッチ回路５を介してリチウムイオン二次電池１－１～１－ｎの各端子に接続されている。スイッチ回路５は、組電池１と第一充電装置２とを切断して、組電池１をなす各リチウムイオン二次電池の端子を選択するのであり、第一充電装置２と組電池１との間の充電経路上に設けられたスイッチＳと、組電池１をなすリチウムイオン二次電池１－１～１－ｎの各端子を選択するためのスイッチＳ－１～Ｓ－ｎから構成される。なお、特に図示しないが、スイッチ回路５の各スイッチの開閉を制御するためシーケンスを実行する制御部が設けられている。

【００１６】次に、このように構成されたリチウムイオン二次電池充電装置の動作を、図２および図３を参照して説明する。このリチウムイオン二次電池充電装置の一連の動作は、上述の制御部による制御の下に行われる。非常時の放電が終わった組電池１を充電する場合、まず初めにスイッチ回路５のスイッチＳをＯＮとし、第一充電装置２が定電流により組電池１を充電する。例えば、単セル当たりの充電完了電圧を４．１Ｖとすると、ｎ個のリチウムイオン二次電池が直列接続された組電池１は、その端子電圧がｎ×４．１Ｖに達するまで第一充電装置２により定電流で充電が行われる。第一充電装置２は、組電池１をなす複数個のリチウムイオン二次電池１－１～１－ｎのうち、何れか一つが満充電状態になるまで組電池１を定電流により充電する。

【００１７】ここで、リチウムイオン二次電池１－１～１－ｎのすべてが、同じ充電時間で４．１Ｖにまで充電されることが理想ではあるが、実際には、充電時間の経過に伴って各リチウムイオン二次電池の内部特性が変化し、電池の容量および内部抵抗が変化する結果、各リチウムイオン二次電池の端子電圧にアンバランスが生じる。このため、リチウムイオン二次電池１－１～１－ｎのうち、どれかが先に充電完了電圧４．１Ｖに達する。図３に示す例では、リチウムイオン二次電池１－ｎの充電電圧Ｖ（１－ｎ）だけが、時刻ｔ１において充電完了電圧４．１Ｖに先に到達し、リチウムイオン二次電池１－１や１－３等の他のセルは充電完了電圧４．１Ｖに達していない。

【００１８】ここで、リチウムイオン二次電池１－ｎが

充電完了電圧４．１Ｖに達した後に継続して組電池１を第一充電装置２により定電流で充電すると、既に充電完了電圧に達したリチウムイオン二次電池１－ｎが過充電となってしまう。そこで、組電池１をなすリチウムイオン二次電池１－１～１－ｎのうちの何れか一つが満充電状態になった場合には、第一充電装置による組電池１の充電を停止させ、第二充電装置３により、満充電状態に至っていない他のリチウムイオン二次電池を１セルずつ充電する。

【００１９】具体的には、電圧プローブ６によりリチウムイオン二次電池１－ｎが満充電状態になったことが検出されると、スイッチＳを開放してＯＦＦとし、第一充電装置２による組電池１の充電を停止する。そして、以下に説明するように、スイッチＳ－１～Ｓ－ｎ＋１を選択的に閉じてＯＮとし、第二充電装置３を使用して、充電完了電圧４．１Ｖに達していないリチウムイオン二次電池１ａ～１ｎをセル毎に定電流で順次充電する。

【００２０】即ち、組電池１をセル毎に充電する場合、電圧プローブ６を用いて各セルの端子電圧をモニターしながら、図２に示すような順番でスイッチＳ－１とＳ－２、スイッチＳ－２とＳ－３、スイッチＳ－３とＳ－４というように、各セルのリチウムイオン二次電池を挟む両端の２個のスイッチを選択的にＯＮとし、第二充電装置３が一セルずつ（セル毎に）リチウムイオン二次電池１－１～１－ｎを順次充電する。

【００２１】図２に、第一充電装置２および第二充電装置３による一連の充電動作におけるスイッチ回路５の状態を示す。この例では、放電終了後の組電池１を第一充電装置２により充電する場合、スイッチＳのみがＯＮとされ、他のスイッチＳ－１～Ｓ－ｎ＋１の全てがＯＦＦとされる。これにより、第一充電装置２のみが組電池１に接続され、この組電池１が定電流で充電される。続いて、組電池１をなす複数個のリチウムイオン二次電池１－１～１－ｎのうち、何れか一つが満充電状態になったことが検出されると、スイッチＳがＯＦＦとされ、第一充電装置２による充電が停止される。そして、リチウムイオン二次電池１－１の両端子に接続された２個のスイッチＳ－１，Ｓ－２のみがＯＮとされ、このセルが第二充電装置３により充電される。このセルが満充電状態になると、リチウムイオン二次電池１－２の両端子に接続された２個のスイッチＳ－２，Ｓ－３のみがＯＮとされ、このセルが満充電状態にまで充電される。

【００２２】以下同様にして、リチウムイオン二次電池１－ｎまで第二充電装置３によりセル毎に順次充電される。これにより、リチウムイオン二次電池１－１～１－ｎの全てが充電完了電圧４．１Ｖに達した状態で、組電池１の端子電圧がｎ×４．１Ｖに達する。この後、スイッチＳ－１～Ｓ－ｎ＋１の全てをＯＦＦとし、スイッチＳを再びＯＮとする。そして、第一充電装置２が組電池１をフロート充電（定電圧充電）し、組電池１をなすリチウムイオン二次電池１－１～１－ｎの全てが満充電状態で、次の非常時の電池放電に備える。

【００２３】（実施の形態２）次に、この発明の実施の形態２を説明する。上述の実施の形態１によれば、スイッチＳをオフして第二充電装置による単セル充電を行っている最中に、停電等による放電要請があった場合、この要請に対応できない。そこで、この実施の形態２では、図４に示すように、負荷４に対して二組の組電池１１，１２を互いに並列に接続し、これら組電池のセル充電を相補的に行う。

【００２４】具体的に構成を説明する。第一充電装置２０は、組電池１１，１２を充電するためのものであって、スイッチＳ１，Ｓ２を介して組電池１１，１２にそれぞれ接続される。組電池１１は、直列接続されたリチウムイオン二次電池１１－１～１１－３からなり、組電池１２は、同じく直列接続されたリチウムイオン二次電池１２－１～１２－３からなる。第二充電装置３０は、組電池１１，１２をセル毎に充電するためのものであって、スイッチ回路５１，５２を介して組電池１１，１２にそれぞれ接続される。スイッチ回路５１は、組電池１１に対する第一充電装置２０の充電経路上に設けられたスイッチＳ１と、リチウムイオン二次電池１１－１～１１－３の各端子を選択するためのスイッチＳ１－１～Ｓ１－４からなる。スイッチ回路５２は、組電池１２に対する第一充電装置２０の充電経路上に設けられたスイッチＳ２と、リチウムイオン二次電池１２－１～１２－３の各端子を選択するためのスイッチＳ２－１～Ｓ２－４からなる。

【００２５】次に、この実施の形態２の動作について、各セルを充電する場合を説明する。まず、第二充電装置３０により組電池１１の単セルの充電を先に行う。即ち、スイッチ回路５１により、リチウムイオン二次電池１１－１～１１－３の端子を順次選択し、この選択された端子の電圧をモニターしながらリチウムイオン二次電池１１－１～１１－３をセル毎に充電する。この組電池１１の単セルの充電が終了すると、その後に、組電池１２の単セルの充電に移行する。即ち、スイッチ回路５２により、リチウムイオン二次電池１２－１～１２－３の端子を順次選択し、この選択された端子の電圧をモニターしながらリチウムイオン二次電池１２－１～１２－３をセル毎に充電する。

【００２６】このように、この実施の形態２によれば、必ず組電池１１か組電池１２が負荷４に対して放電可能な状態で並列に接続されていることになる。従って、第二充電装置３０による単セル充電を行っている最中に、停電等による非常時の放電要請があったとしても、これに対応することが可能となる。また、上述の実施の形態によれば、何れか一つのリチウムイオン二次電池が満充電状態に達した後は、セル毎に端子電圧をモニターして充電するようにしたので、セル間の端子電圧のアンバラ

ンス（即ち各セルの容量や内部抵抗のバラツキ）に起因する過充電や充電不足を容易に解消することができ、複数個のリチウムイオン二次電池をバランス良く満充電状態にまで充電すると共に、これらリチウムイオン二次電池からなる組電池を満充電状態にまで充電することができる。従って、各リチウムイオン二次電池の能力を有効に活用することが可能になる。

【0027】さらに、上述の実施の形態によれば、直列接続された複数個のリチウムイオン二次電池の充電を目的の異なる二種類の充電装置により、セルのバランスを調整することで、複雑な電子部品や高精度な電圧判定回路を要することなく、安価なリチウムイオン二次電池充電装置を容易に実現することができる。なお、この発明は、上述の実施の形態に限定されるものではなく、要旨を変えない範囲で種々変形可能である。例えば、上述の各実施の形態では、組電池をバックアップ用として使用するものとしたが、これに限定されることなく、この組電池を主電源として使用する場合にも本発明を適用することができる。

【0028】（実施の形態３）次に、この発明の実施の形態３を説明する。上述の実施の形態１によれば、第二充電装置３により組電池１をなすリチウムイオン二次電池１－１～１－ｎの全てが４．１Ｖにまで充電されると、組電池１の端子電圧がｎ×４．１Ｖとなり、その後、組電池１は、ｎ×４．１Ｖの電圧で第一充電装置１によりフロート充電された状態に移行する。このフロート充電の状態が長期間に及ぶと、組電池１をなす複数のリチウムイオン二次電池の特性上のバラツキ（例えば内部抵抗のバラツキ）に起因して各セル（リチウムイオン二次電池）の端子電圧にアンバランスが生じ、その結果、組電池１の放電容量が低下して放電持続時間が短くなる場合がある。

【0029】図５（ａ）に、フロート充電状態にある組電池１の各セルの端子電圧を示す。この図に示す例は、上述の実施の形態１において、１セルあたり４．１Ｖとして第一充電装置２により組電池１をフロート充電する場合を想定したものであって、ｎ個のリチウムイオン二次電池からなる組電池１の端子電圧はｎ×４．１Ｖに維持される。同図から理解されるように、充電初期では、各セルの端子電圧は比較的そろっているが、フロート充電時間の経過に伴って各セルの端子電圧に徐々にバラツキが生じ、次第にそのバラツキが拡大する傾向を示す。このように各セルの端子電圧にバラツキが存在すると、直列接続された複数のリチウムイオン二次電池１－１～１－ｎのうち、一部のリチウムイオン二次電池（セル）の端子電圧が低下する。このため、組電池１の放電容量が、端子電圧の低下したセルの制約を受けるため、放電時間が短くなる。図６に、各セルの放電特性（放電電流一定）の一例を示す。同図において、特性曲線Ｖ１ａ，Ｖ１ｃ，Ｖ１ｎは、バラツキによる放電電圧の低下の度合いが、小、中、大の場合を示している。同図から理解されるように、放電電圧の低下の度合いが大きい程、放電終止電圧（３Ｖ）に到達するまでの放電時間（ｔ１）が短くなる。

【0030】上述の放電時間に関する不都合に加えて、リチウムイオン二次電池の場合、過放電により端子電圧が極端に低下すると、負電極の集電体である銅の溶出が起きることによって損傷を受け、電池容量が著しく低下する結果、組電池１から負荷４への電力供給時間（放電時間）が設計された時間よりも遙かに短くなってしまうという不都合も抱えている。このため、リチウムイオン二次電池を過放電から保護する必要上、個々のリチウムイオン二次電池の端子電圧が極端に低下することを防止する必要がある。実施の形態２についても同様の不都合が存在する。この実施の形態３に係るリチウムイオン二次電池充電装置は、上述したような不都合を解消するものであって、フロート充電状態において、組電池１をなす各リチウムイオン二次電池の端子電圧のバラツキを抑える機能と、各リチウムイオン二次電池を過放電から保護する機能とを備える。

【0031】以下、この実施の形態３に係るリチウムイオン二次電池充電装置について、前述の図１を援用すると共に、図５ないし図７を参照して説明する。この実施の形態３に係るリチウムイオン二次電池充電装置の構成は、前述の図１に示す実施の形態１に係るリチウムイオン二次電池充電装置の構成と基本的には同様であるが、フロート充電での第一充電装置２の動作状態が異なっている。図７に、この実施の形態３に係る第一充電装置２および第二充電装置３の各動作状態と出力状態との関係を示す。同図において、「回復充電モード」は、図２に示す「第一充電装置による組電池定電流充電」および「第二充電装置による単セル定電流充電」に対応した動作モードであり、「フロート充電モード」は、「第一充電装置による組電池フロート充電」に対応した動作モードである。また「第一の充電電圧」は、第二の充電装置３により複数個のリチウムイオン二次電池１－１～１－ｎが充電されたことによって組電池１の端子電圧として現れる電圧（この例ではｎ×４．１Ｖ）である。さらに「第二の充電電圧」は、組電池１が満充電状態にあるものと見なし得る限度において、第一の充電電圧よりも低く設定された所定の電圧である。この実施の形態３では、第二の充電電圧の下限を１００ｍＶとし、第二の充電電圧を１セルあたり４．０５Ｖ程度に設定する。さらに、図７に示す「第一充電装置による組電池定電流充電」、「第二充電装置による単セル定電流充電」、および「第一充電装置による組電池フロート充電」の各モードでのスイッチＳ，Ｓ－１，～Ｓ－ｎ＋１の状態（ＯＮ／ＯＦＦ）については図２と同様である。

【0032】同図から理解されるように、「回復充電モード」において、「第一充電装置による組電池定電流充

電」の項目については、第一充電装置2が「ON」とされ、第二充電装置3が「OFF」とされる。このとき、第一充電装置2は第一の充電電圧を出力する。また、「回復充電モード」において、「第二充電装置による単独定電流充電」の項目については、第一充電装置2が「ON」に維持され、第二充電装置3が「ON」とされる。このとき、第一充電装置2および第二の充電装置3の双方が第一の充電電圧を出力する。この後、回復充電モードからフロート充電モードに移行し、「第一充電装置による組電池フロート充電」の制御が行われる。この項目では、第一充電装置2が「ON」に維持され、第二充電装置3が「OFF」とされる。このとき、第一充電装置2が第二の充電電圧を出力する。このように、フロート充電に移行すると、組電池1は、第一の充電電圧よりも低い第二の充電電圧に設定される。

【0033】図5（b）に、1セルあたりの端子電圧を4．05Vとして第二の充電電圧を設定した場合における各リチウムイオン二次電池の端子電圧を示す。同図から理解されるように、長期間にわたって組電池1をフロート充電状態においても、組電池1をなす各リチウムイオン二次電池の端子電圧のバラツキは小さく抑制され、しかもこのバラツキはほとんど拡大しない。なお、上述のフロート充電時に1セルあたり4．05Vとして第二の充電電圧を設定したが、これは一例であって、組電池に使用するセルの特性に応じて第二の充電電圧を適切に設定すればよい。その下限値についても同様である。以上のように、回復充電モードでは、上述の実施の形態1と同様に第一の充電電圧で組電池1を充電し、フロート充電モードでは、第一の充電電圧よりも低い第二の充電電圧で組電池1のフロート充電を行う。これにより、フロート充電期間中の各セルの端子電圧のバラツキ、とりわけ各セルの端子電圧の低下を抑制し、組電池1の放電容量を確保している。

【0034】次に、リチウムイオン二次電池の過放電を防止するための機能について説明する。上述したように、組電池1をなすリチウムイオン二次電池の過放電を防止する必要がある。この実施の形態3では、非常時に組電池1から負荷4に対して放電が行われる際、組電池1をなす各セルの端子電圧を電圧プローブ6でモニターし、何れかのセルの端子電圧が所定値にまで低下した場合、スイッチSを開放させることにより、負荷4に対する組電池1の放電を停止させる。これにより、組電池1をなす各リチウムイオン二次電池の過放電を防止する。スイッチSを開放するための条件である所定の電圧（プローブ6によるモニター値）は、リチウムイオン二次電池の構成材料によって異なるが、正極にコバルト酸リチウムやマンガン酸リチウムを使用したものでは、1セルあたり2．5Vが目安となる。以上で実施の形態3を説明した。

【0035】以上、この発明の実施の形態を説明したが、この発明は上述の実施の形態に限定されるものではなく、この発明の要旨を逸脱しない範囲での設計変更を含む。例えば、上述の実施の形態3では、実施の形態1の構成を前提としたが、実施の形態2の構成を前提として同様に構成してもよい。また、上述の実施の形態3では、フロート充電モードでの充電電圧を低下させるための制御と、過放電を防止するための制御を併用するものとしたが、これに限定されることなく、何れかの制御を行うものとしてもよく、これらの制御と上述の実施の形態1および2とどのように組み合わせてもよい。

【0036】

【発明の効果】以上説明したように、この発明によれば、直列接続された複数個のリチウムイオン二次電池組電池のそれぞれの電池電圧を検出し、いずれか一つの電池が充電完了電圧に到達すると第一充電装置による充電を停止し、その他の電池に対して第二充電装置により、充電完了電圧に到達するまで順番に充電するようにしたので、直列接続された複数個のリチウムイオン二次電池からなる組電池を、フロート充電状態で待機している場合に効率的に充電することが可能となり、そのようなリチウムイオン二次電池充電装置を安価に実現することができる。

【図面の簡単な説明】

【図1】 この発明の実施の形態1に係るリチウムイオン二次電池充電装置の構成を示す図である。

【図2】 この発明の実施の形態1に係るリチウムイオン二次電池充電装置が有するスイッチの開閉状態（ON／OFF）を説明するための図である。

【図3】 この発明の実施の形態1に係るリチウムイオン二次電池の充電時の電圧特性および電流特性を示す図である。

【図4】 この発明の実施の形態2に係るリチウムイオン二次電池充電装置の構成を示す図である。

【図5】 この発明の実施の形態3に係るリチウムイオン二次電池充電装置による組電池の端子電圧（フロート充電時）の特性を示す特性図である。

【図6】 この発明の実施の形態3に係る組電池の端子電圧（放電時の電圧）のバラツキを説明するための特性図である。

【図7】 この発明の実施の形態3に係るリチウムイオン二次電池充電装置の動作を説明するための図である。

【符号の説明】

1，11，12…組電池（直列接続された複数個のリチウムイオン二次電池）

1－1～1－n…リチウムイオン二次電池（セル）

2，20…第一充電装置

3，30…第二充電装置

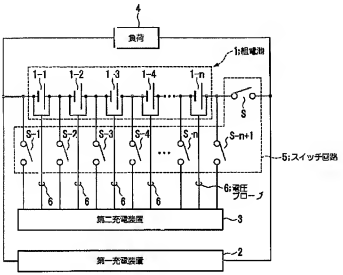
4…負荷

5，51，52…スイッチ回路

6，60…電圧プローブ

S，S1，S2…スイッチ　　S2-4…スイッチ
S-1～S-n+1，S1-1～S1-4，S2-1～

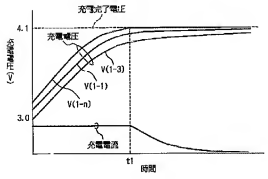
【図1】



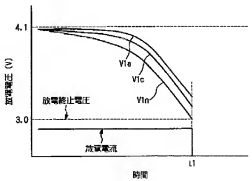

【図2】

| スイッチ | 第一充電装置による組電池定電流充電 | 第二充電装置による単セル定電流充電 | | | | | 第一充電装置による組電池プロート充電 |
|---|---|---|---|---|---|---|---|
| | | セル1-1 | セル1-2 | セル1-3 | ------- | セル1-n | |
| S | ON | OFF | OFF | OFF | ------- | OFF | ON |
| S-1 | OFF | ON | OFF | OFF | ------- | OFF | OFF |
| S-2 | OFF | ON | ON | OFF | ------- | OFF | OFF |
| S-3 | OFF | OFF | ON | ON | ------- | OFF | OFF |
| S-4 | OFF | OFF | OFF | ON | ------- | OFF | OFF |
| ≀ | ≀ | ≀ | ≀ | ≀ | ≀ | ≀ | ≀ |
| S-n | OFF | OFF | OFF | OFF | ------- | ON | OFF |
| S-n+1 | OFF | OFF | OFF | OFF | ------- | ON | OFF |

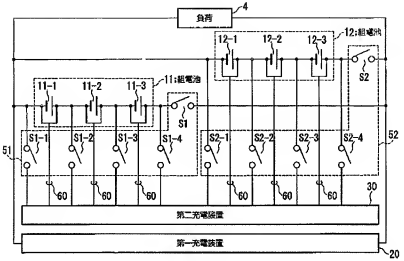
【図3】



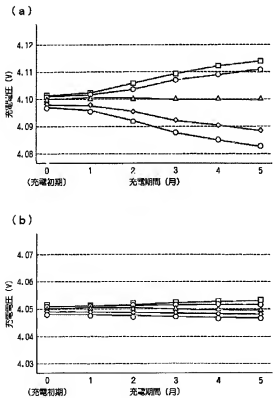

【図6】



【図4】


負荷
4
12-1
12-2
12-3
12:組電池
S2
11-1
11-2
11-3
11:組電池
S1
S1-1
S1-2
S1-3
S1-4
S2-1
S2-2
S2-3
S2-4
51
52
60
30
第二充電装置
第一充電装置
20

【図5】


(a)
4.12
4.11
4.10
4.09
4.08
充電電圧 (V)
0
1
2
3
4
5
(充電初期)
充電期間 (月)
(b)
4.07
4.06
4.05
4.04
4.03
充電電圧 (V)
0
1
2
3
4
5
(充電初期)
充電期間 (月)

【図7】

| モード | 回復充電モード | | フロート充電モード |
|---|---|---|---|
| | 第一充電装置による組電池定電流充電 | 第二充電装置による単セル定電流充電 | 第一充電装置による組電池フロート充電 |
| 第一充電装置 | ON | | |
| 第二充電装置 | OFF | ON | OFF |
| 充電装置出力電圧 | 第一の充電電圧<br>(第一充電装置および第二充電装置の出力電圧は時一の値) | | 第二の充電電圧<br>(第一充電装置) |

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フロントページの続き

Fターム(参考) 5G003 AA01 BA03 CA02 CA14 CC02
5H030 AA09 AS14 BB03 BB04 FF43
FF44

## CLAIMS

[Claim(s)]
[Claim 1]In charging equipment for charging a cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out, The first charging equipment that charges said cell group, and a switch switching means for choosing a terminal of each rechargeable lithium-ion battery which forms said cell group, Rechargeable lithium-ion battery charging equipment which having had the second charging equipment that charges two or more rechargeable lithium-ion batteries which form said cell group while monitoring voltage of a terminal with said selected switch switching means for every cell, and constituting.
[Claim 2]In rechargeable lithium-ion battery charging equipment indicated to claim 1, said first charging equipment, Charge until any one of two or more rechargeable lithium-ion batteries which form said cell group will be in a full charge state, and said cell group said second charging equipment, When any one of two or more rechargeable lithium-ion batteries which form said cell group changes into a full charge state, Rechargeable lithium-ion battery charging equipment charging at a time one cell of other rechargeable lithium-ion batteries which have not resulted in a full charge state among said two or more rechargeable lithium-ion batteries.
[Claim 3]In charging equipment for charging the first and the second cell group by which are cell groups which consist of two or more rechargeable lithium-ion batteries by which the series connection was carried out, and multiple connection was carried out mutually, The first charging equipment that charges said first cell group and the second cell group, The first switch switching means for choosing a terminal of each rechargeable lithium-ion battery which forms said first cell group, The second switch switching means for choosing a terminal of each rechargeable lithium-ion battery which forms said second cell group, Two or more rechargeable lithium-ion batteries which form said first cell group while monitoring voltage of a terminal with said first selected switch switching means are charged for every cell, Rechargeable lithium-ion battery charging equipment which having had the second charging equipment that charges two or more rechargeable lithium-ion batteries which form said second cell group while monitoring voltage of a terminal with said second selected switch switching means for every cell, and constituting.
[Claim 4]A charging method characterized by comprising the following for charging a cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out.
(a) A step which charges said cell group by constant current until any one of two or more rechargeable lithium-ion batteries which form said cell group will be in a full charge state.
(b) When any one of two or more rechargeable lithium-ion batteries which form said cell group changes into a full charge state, A step which charges at a time one cell of other rechargeable lithium-ion batteries which have not resulted in a full charge state among said two or more rechargeable lithium-ion batteries by constant current, and a step which carries out the float charge of said cell group after charging two or more rechargeable lithium-ion batteries which form the (c) aforementioned cell group for every cell.

[Claim 5]Said first charging equipment, By having charged said two or more rechargeable lithium-

ion batteries by said second charging equipment. Rechargeable lithium-ion battery charging equipment indicated to claim 1 or 2 carrying out the float charge of said cell group on the second voltage lower than the first voltage that appears as terminal voltage of said cell group.
[Claim 6]Said first charging equipment, By having charged two or more rechargeable lithium-ion batteries which form said first and the second cell group with said second charging equipment. Rechargeable lithium-ion battery charging equipment indicated to claim 3 carrying out the float charge of said first and the second cell group on the second voltage lower than the first voltage that appears as terminal voltage of said first and the second cell group.
[Claim 7]At a step which carries out a float charge, said cell group. A lithium ion rechargeable battery charging method indicated to claim 4 carrying out the float charge of said cell group on the second voltage lower than the first voltage that appears as terminal voltage of said cell group by having charged said two or more rechargeable lithium-ion batteries by said second charging equipment.
[Claim 8]Rechargeable lithium-ion battery charging equipment indicated in any 1 paragraph of claims 1 thru/or 3 having a means to stop discharge of said cell group when each terminal voltage of two or more rechargeable lithium-ion batteries which form said cell group is monitored and which terminal voltage falls even to a predetermined value.

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[Translation done.]

## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the rechargeable lithium-ion battery charging equipment and the method for charging a rechargeable lithium-ion battery. Two or more rechargeable lithium-ion batteries are the things about the charging equipment and the method of performing charge of each single cell in the cell group connected series and in the shape of parallel with sufficient balance in detail. It is related with the art of charging cheaply and efficiently the cell group used standing by by a charging state by a float charge without using a complicated control circuit.
[0002]
[Description of the Prior Art]Generally, mobile radio communication apparatus, such as a portable telephone and a cordless telephone, is begun, and many rechargeable lithium-ion batteries with high volume energy density and weight energy density are used in the video camera or the notebook sized personal computer.This rechargeable lithium-ion battery carries out the series connection of the plurality, and is used as a cell group, and usually is used as a power supply of the above-mentioned electronic equipment.
[0003][Problem(s) to be Solved by the Invention]By the way, charge completion voltage is conventionally set as the constant value of per [ 4.1V or 4.2V ] single cell as a charging system of a rechargeable lithium-ion battery, After charging with a constant current value and reaching charge completion voltage until cell voltage reaches such charge completion voltage, the constant current and the constant-potential-charge method which shifts to constant potential charge are adopted. If charge completion voltage per single cell is set to 4.1V, for example when charging the cell group which consists of n rechargeable lithium-ion batteries (n is arbitrary natural numbers) by which the series connection was carried out according to this method, constant current charge will be performed to a cell group until the terminal voltage of a cell group is set to nx4.1V.
[0004]However, if imbalance exists in the terminal voltage between cells, before the terminal voltage of a cell group amounts to nx4.1V, the state where any one cell reaches charge completion voltage, and other cells have not reached charge completion voltage will happen. For this reason, it is carried out by constant current charge continuing to the cell which reached charge completion voltage previously, and there is a problem that the rechargeable lithium-ion battery of this cell will be in an overcharging condition.
[0005]This problem is explained further. If each capacity and internal resistance of a rechargeable lithium-ion battery are always the same when charging the cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out by a float charge method, all the rechargeable lithium-ion batteries can be charged with sufficient balance. However, dispersion in some exists in the capacity and internal resistance of each rechargeable lithium-ion battery actually. Even if the internal resistance of each rechargeable lithium-ion battery is the same in the first stage, the internal characteristic of a cell changes in connection with the passage of time, and the capacity and internal resistance of each rechargeable lithium-ion battery also change with float charges. As a result, the balance

on the characteristic of each rechargeable lithium-ion battery will collapse, and the specific rechargeable lithium-ion battery which forms a cell group will be in an overcharging condition.
[0006]If a cell group reaches a full charge state, constant current charge will be completed, but when a specific rechargeable lithium-ion battery will be in an overcharging condition, charge will be completed in the state where other rechargeable lithium-ion batteries which form this cell group do not reach a full charge state. Therefore, there is also a problem of it becoming impossible to fully utilize the capability which these rechargeable lithium-ion batteries hold. Thus, according to the conventional charging system, there is a problem that each rechargeable lithium-ion battery which forms a cell group cannot be charged with sufficient balance even at a full charge state.
[0007]The place which this invention makes that purpose in light of the above-mentioned circumstances, It is in providing the rechargeable lithium-ion battery charging equipment and the method of making it possible to charge cheaply and efficiently the cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out, when standing by in the state of a float charge.
[0008]
[Means for Solving the Problem]In order to solve an aforementioned problem, this invention has the following composition. Rechargeable lithium-ion battery charging equipment concerning an invention indicated to claim 1, In charging equipment for charging a cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out, The first charging equipment that charges said cell group, and a switch switching means for choosing a terminal of each rechargeable lithium-ion battery which forms said cell group, Monitoring voltage of a terminal with said selected switch switching means, it had the second charging equipment that charges two or more rechargeable lithium-ion batteries which form said cell group for every cell, and was constituted.
[0009]Rechargeable lithium-ion battery charging equipment concerning an invention indicated to claim 2, In rechargeable lithium-ion battery charging equipment indicated to claim 1, said first charging equipment, Said cell group is charged until any one of two or more rechargeable lithium-ion batteries which form said cell group will be in a full charge state, When any one of two or more rechargeable lithium-ion batteries with which said second charging equipment forms said cell group changes into a full charge state, it charges at a time one cell of other rechargeable lithium-ion batteries which have not resulted in a full charge state among said two or more rechargeable lithium-ion batteries.
[0010]Rechargeable lithium-ion battery charging equipment concerning an invention indicated to claim 3, In charging equipment for charging the first and the second cell group by which are cell groups which consist of two or more rechargeable lithium-ion batteries by which the series connection was carried out, and multiple connection was carried out mutually, The first charging equipment that charges said first cell group and the second cell group, The first switch switching means for choosing a terminal of each rechargeable lithium-ion battery which forms said first cell group, The second switch switching means for choosing a terminal of each rechargeable lithium-ion battery which forms said second cell group, Two or more rechargeable lithium-ion batteries which form said first cell group while monitoring voltage of a terminal with said first selected switch switching means are charged for every cell, Monitoring voltage of a terminal with said second selected switch switching means, it had the second charging equipment that charges two or more rechargeable lithium-ion batteries which form said second cell group for every cell, and was constituted.
[0011]A lithium ion rechargeable battery charging method concerning an invention indicated to claim 4 equips with the following a charging method for charging a cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out.
(a) A step which charges said cell group by constant current until any one of two or more rechargeable lithium-ion batteries which form said cell group will be in a full charge state.
(b) A step which charges at a time one cell of other rechargeable lithium-ion batteries which have not resulted in a full charge state among said two or more rechargeable lithium-ion batteries by constant current when any one of two or more rechargeable lithium-ion batteries

which form said cell group changes into a full charge state.
(c) A step which carries out the float charge of said cell group after charging two or more rechargeable lithium-ion batteries which form said cell group for every cell.

[0012]Rechargeable lithium-ion battery charging equipment concerning an invention indicated to claim 5, In rechargeable lithium-ion battery charging equipment indicated to claim 1 or 2, The float charge of said cell group is carried out on the second voltage lower than the first voltage in which said first charging equipment appears as terminal voltage of said cell group by having charged said two or more rechargeable lithium-ion batteries by said second charging equipment. Rechargeable lithium-ion battery charging equipment concerning an invention indicated to claim 6, In rechargeable lithium-ion battery charging equipment indicated to claim 3, said first charging equipment, By having charged two or more rechargeable lithium-ion batteries which form said first and the second cell group with said second charging equipment. The float charge of said first and the second cell group is carried out on the second voltage lower than the first voltage that appears as terminal voltage of said first and the second cell group. A lithium ion rechargeable battery charging method concerning an invention indicated to claim 7, At a step which carries out a float charge, said cell group. In a lithium ion rechargeable battery charging method indicated to claim 4, The float charge of said cell group is carried out on the second voltage lower than the first voltage that appears as terminal voltage of said cell group by having charged said two or more rechargeable lithium-ion batteries by said second charging equipment. Rechargeable lithium-ion battery charging equipment concerning an invention indicated to claim 8, In rechargeable lithium-ion battery charging equipment indicated in any 1 paragraph of claims 1, 2, and 3, When each terminal voltage of two or more rechargeable lithium-ion batteries which form said cell group was monitored and which terminal voltage fell even to a predetermined value, it had a means to stop discharge of said cell group.
[0013]When two or more rechargeable lithium-ion batteries by which the series connection was carried out are charged according to composition of this invention, After it charges by constant current and one of cells reaches charge completion voltage until it has applied the first charging equipment, it shifts and that cell reaches charge completion voltage, The first charging equipment linked to a cell group is separated, and other cells which have not reached charge completion voltage with the application of the second charging equipment that can charge a single cell are charged to charge completion voltage in order.
[0014]
[Embodiment of the Invention]Hereafter, the embodiment of this invention is described with reference to drawings. The term which it "cell" Comes to set to this embodiment shall express each rechargeable lithium-ion battery which forms a cell group. The composition and the example of application of rechargeable lithium-ion battery charging equipment concerning this Embodiment 1 are shown in drawing 1. In drawing 1, the cell group 1 functions as a power supply for backup, comprises two or more rechargeable lithium-ion batteries 1-1 by which the series connection was carried out - 1-n, and supplies direct current power to the load 4 in an emergency. In the following explanation, two or more rechargeable lithium-ion batteries 1-1 - each of 1-n which make the cell group 1 are suitably called a "single cell."
[0015]The first charging equipment 2 is a charging means for charging intratemporally the rechargeable lithium-ion battery 1-1 - 1-n which make the cell group 1, and is connected to the cell group 1 via the switch S. The second charging equipment 3 is small charging equipment which has the charging capacity of the grade that the single cell of the cell group 1 can be charged, and is connected to each terminal of the rechargeable lithium-ion battery 1-1 - 1-n via the switching circuit 5. The switch S which the switching circuit 5 disconnected the cell group 1 and the first charging equipment 2, chooses the terminal of each rechargeable lithium-ion battery which forms the cell group 1, and was formed on the charge path between the first charging equipment 2 and the cell group 1. It comprises the switch S-1 for choosing each terminal of the rechargeable lithium-ion battery 1-1 - 1-n which make the cell group 1 - S-n. Although not illustrated in particular, in order to control opening and closing of each switch of the switching circuit 5, the control section which performs a sequence is provided.

[0016]Next, operation of the rechargeable lithium-ion battery charging equipment constituted in this way is explained with reference to drawing 2 and drawing 3. Operation of a series of this rechargeable lithium-ion battery charging equipment is performed under control by an above-mentioned control section. When charging the cell group 1 which the discharge in an emergency finished, the switch S of the switching circuit 5 is first set to ON, and the first charging equipment 2 charges the cell group 1 according to constant current. For example, if charge completion voltage per single cell is set to 4.1V, as for the cell group 1 with which the series connection of the n rechargeable lithium-ion batteries was carried out, charge will be performed by the first charging equipment 2 by constant current until the terminal voltage amounts to nx4.1V. The first charging equipment 2 charges the cell group 1 according to constant current until any one of two or more rechargeable lithium-ion batteries 1-1 - 1-n which make the cell group 1 will be in a full charge state.

[0017]Although it is an ideal here that all of the rechargeable lithium-ion batteries 1-1 - 1-n are charged by even 4.1V by the same charging time, As a result of the internal characteristic of each rechargeable lithium-ion battery changing with progress of charging time and the capacity and internal resistance of a cell changing actually, imbalance arises in the terminal voltage of each rechargeable lithium-ion battery. For this reason, either reaches the charge completion voltage 4.1V previously among the rechargeable lithium-ion battery 1-1 - 1-n. In the example shown in drawing 3, the charge voltages V of rechargeable lithium-ion battery 1-n (1-n) reach the charge completion voltage 4.1V previously in the time t1, and other cells of the rechargeable lithium-ion battery 1-1 or 1-3 grade have not reached the charge completion voltage 4.1V.

[0018]Here, if the cell group 1 is continuously charged by constant current with the first charging equipment 2 after rechargeable lithium-ion battery 1-n reaches the charge completion voltage 4.1V, rechargeable lithium-ion battery 1-n which already reached charge completion voltage will be a surcharge. So, when any one of the rechargeable lithium-ion batteries 1-1 - 1-n which make the cell group 1 changes into a full charge state, charge of the cell group 1 by the first charging equipment is stopped, and it charges at a time one cell of other rechargeable lithium-ion batteries which have not resulted in the full charge state with the second charging equipment 3.

[0019]If it is specifically detected that rechargeable lithium-ion battery 1-n changed into the full charge state with the voltage probe 6, the switch S will be opened wide, it will set to OFF, and charge of the cell group 1 by the first charging equipment 2 will be suspended. And the switch S-1 - S-n+1 are closed selectively, it sets to ON, the second charging equipment 3 is used, and the rechargeable lithium-ion batteries 1a-1n which have not reached the charge completion voltage 4.1V are charged one by one by constant current for every cell so that it may explain below.

[0020]Namely, when charging the cell group 1 for every cell, in turn as shown in drawing 2, monitoring the terminal voltage of each cell using the voltage probe 6 like the switch S-1, S-2 and the switch S-2, S-3 and the switch S-3, and S-4, Two switches of the both ends which sandwich the rechargeable lithium-ion battery of each cell are selectively set to ON, and the second charging equipment 3 charges the rechargeable lithium-ion battery 1-1 - 1-n of one cell at a time one by one (every cell).

[0021]The state of the switching circuit 5 in a series of charging operation by the first charging equipment 2 and the second charging equipment 3 is shown in drawing 2. In this example, when charging the cell group 1 after a discharge end with the first charging equipment 2, the switch S is set to ON and all other switches S-1 - S-n+1 are set to OFF. Thereby, only the first charging equipment 2 is connected to the cell group 1, and this cell group 1 is charged by constant current. Then, if it is detected that any one of two or more rechargeable lithium-ion batteries 1-1 - 1-n which make the cell group 1 changed into the full charge state, the switch S will be set to OFF and charge by the first charging equipment 2 will be suspended. And only the two switches S-1 connected to both the terminals of the rechargeable lithium-ion battery 1-1 and S-2 are set to ON, and this cell is charged by the second charging equipment 3. If this cell will be in a full charge state, only the two switches S-2 connected to both the terminals of the rechargeable lithium-ion battery 1-2 and S-3 will be set to ON, and this cell will be charged by

even the full charge state.
[0022]It charges one by one for every cell with the second charging equipment 3 to rechargeable lithium-ion battery 1-n like the following. Thereby, after all of the rechargeable lithium-ion batteries 1-1 - 1-n have reached the charge completion voltage 4.1V, the terminal voltage of the cell group 1 amounts to nx4.1V. Then, all the switches S-1 - S-n+1 are set to OFF, and the switch S is again set to ON. And the first charging equipment 2 carries out the float charge (constant potential charge) of the cell group 1, and all of the rechargeable lithium-ion batteries 1-1 - 1-n which make the cell group 1 prepare for the battery discharge in the next emergency in the state of a full charge.
[0023](Embodiment 2), next this embodiment of the invention 2 are described. When there is a discharge request by interruption to service etc. in the midst of according to the above-mentioned Embodiment 1 turning off the switch S and performing single cell charge by the second charging equipment, it cannot respond to this request. So, in this Embodiment 2, as shown in drawing 4, 2 sets of cell groups 11 and 12 are mutually connected in parallel to the load 4, and cell charge of these cell groups is performed complementarily.
[0024]Composition is explained concretely. The first charging equipment 20 is for charging the cell groups 11 and 12, and is connected to the cell groups 11 and 12 via the switch S1 and S2, respectively. The cell group 11 consists of the rechargeable lithium-ion battery 11-1 to 11-3 by which the series connection was carried out, and the cell group 12 consists of the rechargeable lithium-ion battery 12-1 to 12-3 by which the series connection was similarly carried out. The second charging equipment 30 is for charging the cell groups 11 and 12 for every cell, and is connected to the cell groups 11 and 12 via the switching circuits 51 and 52, respectively. The switching circuit 51 consists of switch S1-1 for choosing switch [ which was formed on the charge path of the first charging equipment 20 to the cell group 11 ] S1, and each terminal of rechargeable lithium-ion battery 11-1 to 11-3 - S1-4. The switching circuit 52 consists of switch S2-1 for choosing the switch S2 formed on the charge path of the first charging equipment 20 to the cell group 12, and each terminal of the rechargeable lithium-ion battery 12-1 to 12-3 - S2-4.
[0025]Next, the case where each cell is charged is explained about operation of this Embodiment 2. First, the single cell of the cell group 11 is previously charged with the second charging equipment 30. Namely, the rechargeable lithium-ion battery 11-1 to 11-3 is charged for every cell, choosing the terminal of the rechargeable lithium-ion battery 11-1 to 11-3 one by one, and monitoring the voltage of this selected terminal by the switching circuit 51. After charge of the single cell of this cell group 11 is completed, it shifts to charge of the single cell of the cell group 12 after that. Namely, the rechargeable lithium-ion battery 12-1 to 12-3 is charged for every cell, choosing the terminal of the rechargeable lithium-ion battery 12-1 to 12-3 one by one, and monitoring the voltage of this selected terminal by the switching circuit 52.
[0026]Thus, according to this Embodiment 2, the cell group 11 or the cell group 12 will always be connected in parallel to the load 4 in the state which can be discharged. Therefore, even if there is a discharge request in an emergency by interruption to service etc. in the midst of performing single cell charge by the second charging equipment 30, it becomes possible to correspond to this. After any one rechargeable lithium-ion battery reaches a full charge state according to the above-mentioned embodiment, Since terminal voltage is monitored for every cell and it was made to charge, the surcharge and insufficient charging resulting from the imbalance (namely, capacity of each cell and variation of internal resistance) of the terminal voltage between cells are easily cancelable, Two or more rechargeable lithium-ion batteries are charged with sufficient balance even at a full charge state, and the cell group which consists of these rechargeable lithium-ion batteries can be charged even at a full charge state. Therefore, it becomes possible to utilize the capability of each rechargeable lithium-ion battery effectively.
[0027]By what the balance of a cell is adjusted for with two kinds of charging equipment with which the purposes differ the charge of two or more rechargeable lithium-ion batteries by which the series connection was carried out according to the above-mentioned embodiment. Cheap rechargeable lithium-ion battery charging equipment can be realized easily, without requiring complicated electronic parts and a highly precise voltage decision circuit. This invention is

variously deformable in the range which is not limited to an above-mentioned embodiment and does not change a gist. For example, in each above-mentioned embodiment, although a cell group shall be used as an object for backup, also when using this cell group as a main power supply, this invention can be applied, without being limited to this.

[0028](Embodiment 3), next this embodiment of the invention 3 are described. If all of the rechargeable lithium-ion batteries 1-1 - 1-n which make the cell group 1 with the second charging equipment 3 are charged by even 4.1V according to the above-mentioned Embodiment 1, The terminal voltage of the cell group 1 is set to nx4.1V, and the cell group 1 shifts to the state where the float charge was carried out by the first charging equipment 1 on the voltage of nx4.1V, after that. If the state of this float charge attains to a long period of time, will originate in the variation (for example, variation of internal resistance) on the characteristic of two or more rechargeable lithium-ion batteries which form the cell group 1, and imbalance will arise in the terminal voltage of each cell (rechargeable lithium-ion battery), As a result, the service capacity of the cell group 1 may fall and discharging duration may become short.

[0029]The terminal voltage of each cell of the cell group 1 in a float charge state is shown in drawing 5 (a). The terminal voltage of the cell group 1 which consists of n rechargeable lithium-ion batteries is maintained by nx4.1V supposing the case where the example shown in this figure carries out the float charge of the cell group 1 with the first charging equipment 2 as per [ 4.1V ] one cell in above-mentioned Embodiment 1. In early stages of charge, although the terminal voltage of each cell has gathered comparatively, in connection with the float charge passage of time, variation arises gradually in the terminal voltage of each cell, and the tendency which the variation expands gradually is shown, so that I may be understood from the figure. Thus, if variation exists in the terminal voltage of each cell, the terminal voltage of two or more rechargeable lithium-ion batteries 1-1 by which the series connection was carried out - the rechargeable lithium-ion battery (cell) of the part among 1-n will fall. For this reason, in order that the service capacity of the cell group 1 may receive the restrictions of a cell to which terminal voltage fell, a charging time value becomes short. An example of the discharge characteristic (discharge current regularity) of each cell is shown in drawing 6. In the figure, the degree of the fall of the discharge voltage by variation shows the adult case into smallness the characteristic curve V1a, V1c, and V1n. A charging time value (t1) until it reaches discharge final voltage (3V) becomes short, so that I may be understood from the figure and the degree of a fall of discharge voltage is large.

[0030]If terminal voltage falls [ in addition to the inconvenience about an above-mentioned charging time value ] extremely by overdischarge in the case of a rechargeable lithium-ion battery, When elution of copper which is a charge collector of the negative electrode occurs, as a result of receiving damage and cell capacity's falling remarkably, the inconvenience of becoming short whether you being Haruka rather than the time when the electric power supply time (charging time value) from the cell group 1 to the load 4 was designed is also held. For this reason, a rechargeable lithium-ion battery is protected from overdischarge, and also [ required ] it is necessary to prevent the terminal voltage of each rechargeable lithium-ion battery from falling extremely. Inconvenience with the same said of Embodiment 2 exists. The rechargeable lithium-ion battery charging equipment concerning this Embodiment 3 is provided with the following.

The function to cancel inconvenience which was mentioned above and to suppress the variation in the terminal voltage of each rechargeable lithium-ion battery which forms the cell group 1 in a float charge state.

The function which protects each rechargeable lithium-ion battery from overdischarge.

[0031]Hereafter, above-mentioned drawing 1 is used and the rechargeable lithium-ion battery charging equipment concerning this Embodiment 3 is explained with reference to drawing 5 thru/or drawing 7. Although the composition of the rechargeable lithium-ion battery charging equipment concerning this Embodiment 3 is fundamentally [ as the composition of the rechargeable lithium-ion battery charging equipment concerning Embodiment 1 shown in above-mentioned drawing 1 ] the same, the operating states of the first charging equipment 2 in a float

charge differ. The relation of each operating state of the first charging equipment 2 and the second charging equipment 3 and output state concerning this Embodiment 3 is shown in drawing 7. It is the operational mode corresponding to "the cell group constant current charge by the first charging equipment" and "the single cell constant current charge by the second charging equipment" which show drawing 2 "recovery charge mode" in the figure, "Float charge mode" is the operational mode corresponding to "the cell group float charge by the first charging equipment." "The first charge voltages" is voltage (this example nx4.1V) which appears as terminal voltage of the cell group 1 by having charged two or more rechargeable lithium-ion batteries 1-1 - 1-n by the second charging equipment 3. Furthermore in the limit which can be regarded as having the cell group 1 in a full charge state, "the second charge voltages" is the predetermined voltage set up lower than the first charge voltages. According to this Embodiment 3, the minimum of the second charge voltages shall be 100 mV, and the second charge voltages are set as about 4.05V per one cell. About the state (ON/OFF) of the switch S in each mode of "the cell group constant current charge by the first charging equipment", "the single cell constant current charge by the second charging equipment", and "the cell group float charge by the first charging equipment" shown in drawing 7, S-1 - S-n+1, it is the same as that of drawing 2.

[0032]In "recovery charge mode", about the item of "the cell group constant current charge by the first charging equipment", the first charging equipment 2 is set to "ON", and the second charging equipment 3 is set to "OFF" so that I may be understood from the figure. At this time, the first charging equipment 2 outputs the first charge voltages. In "recovery charge mode", about the item of "the single cell constant current charge by the second charging equipment", the first charging equipment 2 is maintained by "ON" and the second charging equipment 3 is set to "ON." At this time, the both sides of the first charging equipment 2 and the second charging equipment 3 output the first charge voltages. Then, it shifts to float charge mode from recovery charge mode, and control of "the cell group float charge by the first charging equipment" is performed. In this item, the first charging equipment 2 is maintained by "ON" and the second charging equipment 3 is set to "OFF." At this time, the first charging equipment 2 outputs the second charge voltages. Thus, if it shifts to a float charge, the cell group 1 will be set as the second charge voltages lower than the first charge voltages.

[0033]The terminal voltage of each rechargeable lithium-ion battery at the time of setting terminal voltage per one cell to 4.05V, and setting the second charge voltages as drawing 5 (b) is shown. Over a long period of time, also in a float charge state, the variation in the terminal voltage of each rechargeable lithium-ion battery which forms the cell group 1 is controlled small, and, moreover, this variation hardly expands the cell group 1 so that I may be understood from the figure. Although the second charge voltages were set up as per [ 4.05V ] one cell at the time of an above-mentioned float charge, this is an example and should just set up the second charge voltages appropriately according to the characteristic of the cell used for a cell group. The same may be said of the lower limit. As mentioned above, in recovery charge mode, the cell group 1 is charged with the first charge voltages like above-mentioned Embodiment 1, and the second charge voltages lower than the first charge voltages perform the float charge of the cell group 1 in float charge mode. Thereby, the fall of the variation in the terminal voltage of each cell in a float charge period and the terminal voltage of division each cell was controlled, and the service capacity of the cell group 1 is secured.

[0034]Next, the function for preventing the overdischarge of a rechargeable lithium-ion battery is explained. As mentioned above, it is necessary to prevent the overdischarge of the rechargeable lithium-ion battery which forms the cell group 1. When discharge is performed from the cell group 1 to the load 4 in this Embodiment 3 in an emergency, When the terminal voltage of each cell which makes the cell group 1 is monitored with the voltage probe 6 and the terminal voltage of which cell falls even to a predetermined value, discharge of the cell group 1 to the load 4 is stopped by making the switch S open wide. This prevents the overdischarge of each rechargeable lithium-ion battery which forms the cell group 1. Although the predetermined voltage (monitor value by the probe 6) which is the conditions for opening the switch S changes with components of a rechargeable lithium-ion battery, in what uses cobalt acid lithium and

manganic acid lithium for an anode, per [ 2.5V ] one cell becomes a rule of thumb. Embodiment 3 was described above.

[0035]As mentioned above, although this embodiment of the invention was described, this invention is not limited to an above-mentioned embodiment, and includes the design variation in the range which does not deviate from the gist of this invention. For example, although premised on the composition of Embodiment 1, the composition of Embodiment 2 may consist of above-mentioned Embodiments 3 similarly as a premise. Although the control for reducing the charge voltages in float charge mode and the control for preventing overdischarge shall be used together in above-mentioned Embodiment 3, Without being limited to this, it is good also as what performs control [ which ], and may combine with these control and above-mentioned Embodiments 1 and 2 how.

[0036]

[Effect of the Invention]As explained above, according to this invention, each cell voltage of two or more rechargeable lithium-ion battery cell groups by which the series connection was carried out is detected, Since charge by the first charging equipment was suspended, and it was made to charge in order with the second charging equipment to other cells if any one cell reached charge completion voltage until it reached charge completion voltage, It becomes possible to charge efficiently [ when standing by in the state of a float charge ] the cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out, and such rechargeable lithium-ion battery charging equipment can be realized cheaply.

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## TECHNICAL FIELD

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[Field of the Invention]This invention relates to the rechargeable lithium-ion battery charging equipment and the method for charging a rechargeable lithium-ion battery. Two or more rechargeable lithium-ion batteries are the things about the charging equipment and the method of performing charge of each single cell in the cell group connected series and in the shape of parallel with sufficient balance in detail, It is related with the art of charging cheaply and efficiently the cell group used standing by by a charging state by a float charge without using a complicated control circuit.

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## EFFECT OF THE INVENTION

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[Effect of the Invention]As explained above, in this invention, each cell voltage of two or more rechargeable lithium-ion battery cell groups by which the series connection was carried out is detected, When any one cell reached charge completion voltage, charge by the first charging equipment was suspended, and it was made to charge in order with the second charging equipment to other cells until it reached charge completion voltage.
Therefore, it becomes possible to charge efficiently [ when standing by in the state of a float charge ] the cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out, and such rechargeable lithium-ion battery charging equipment can be realized cheaply.

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PRIOR ART

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[Description of the Prior Art]Generally, mobile radio communication apparatus, such as a portable telephone and a cordless telephone, is begun, and many rechargeable lithium-ion batteries with high volume energy density and weight energy density are used in the video camera or the notebook sized personal computer.This rechargeable lithium-ion battery carries out the series connection of the plurality, and is used as a cell group, and usually is used as a power supply of the above-mentioned electronic equipment.
[0003]

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[Translation done.]

## TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]By the way, charge completion voltage is conventionally set as the constant value of per [ 4.1V or 4.2V ] single cell as a charging system of a rechargeable lithium-ion battery, After charging with a constant current value and reaching charge completion voltage until cell voltage reaches such charge completion voltage, the constant current and the constant-potential-charge method which shifts to constant potential charge are adopted. If charge completion voltage per single cell is set to 4.1V, for example when charging the cell group which consists of n rechargeable lithium-ion batteries (n is arbitrary natural numbers) by which the series connection was carried out according to this method, constant current charge will be performed to a cell group until the terminal voltage of a cell group is set to nx4.1V.

[0004]However, if imbalance exists in the terminal voltage between cells, before the terminal voltage of a cell group amounts to nx4.1V, the state where any one cell reaches charge completion voltage, and other cells have not reached charge completion voltage will happen. For this reason, it is carried out by constant current charge continuing to the cell which reached charge completion voltage previously, and there is a problem that the rechargeable lithium-ion battery of this cell will be in an overcharging condition.

[0005]This problem is explained further. If each capacity and internal resistance of a rechargeable lithium-ion battery are always the same when charging the cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out by a float charge method, all the rechargeable lithium-ion batteries can be charged with sufficient balance. However, dispersion in some exists in the capacity and internal resistance of each rechargeable lithium-ion battery actually. Even if the internal resistance of each rechargeable lithium-ion battery is the same in the first stage, the internal characteristic of a cell changes in connection with the passage of time, and the capacity and internal resistance of each rechargeable lithium-ion battery also change with float charges. As a result, the balance on the characteristic of each rechargeable lithium-ion battery will collapse, and the specific rechargeable lithium-ion battery which forms a cell group will be in an overcharging condition.

[0006]If a cell group reaches a full charge state, constant current charge will be completed, but when a specific rechargeable lithium-ion battery will be in an overcharging condition, charge will be completed in the state where other rechargeable lithium-ion batteries which form this cell group do not reach a full charge state. Therefore, there is also a problem of it becoming impossible to fully utilize the capability which these rechargeable lithium-ion batteries hold. Thus, according to the conventional charging system, there is a problem that each rechargeable lithium-ion battery which forms a cell group cannot be charged with sufficient balance even at a full charge state.

[0007]The place which this invention makes that purpose in light of the above-mentioned circumstances, It is in providing the rechargeable lithium-ion battery charging equipment and the method of making it possible to charge cheaply and efficiently the cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out, when standing by in the state of a float charge.

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## MEANS

[Means for Solving the Problem]In order to solve an aforementioned problem, this invention has the following composition. Rechargeable lithium-ion battery charging equipment concerning an invention indicated to claim 1, In charging equipment for charging a cell group which consists of two or more rechargeable lithium-ion batteries by which the series connection was carried out, The first charging equipment that charges said cell group, and a switch switching means for choosing a terminal of each rechargeable lithium-ion battery which forms said cell group, Monitoring voltage of a terminal with said selected switch switching means, it had the second charging equipment that charges two or more rechargeable lithium-ion batteries which form said cell group for every cell, and was constituted.

## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a figure showing the composition of the rechargeable lithium-ion battery charging equipment concerning this embodiment of the invention 1.
[Drawing 2]It is a figure for explaining the switching condition (ON/OFF) of the switch which the rechargeable lithium-ion battery charging equipment concerning this embodiment of the invention 1 has.
[Drawing 3]It is a figure showing the voltage characteristic and the current characteristic at the time of charge of the rechargeable lithium-ion battery concerning this embodiment of the invention 1.
[Drawing 4]It is a figure showing the composition of the rechargeable lithium-ion battery charging equipment concerning this embodiment of the invention 2.
[Drawing 5]It is a characteristic figure showing the characteristic of the terminal voltage (at the time of a float charge) of the cell group by the rechargeable lithium-ion battery charging equipment concerning this embodiment of the invention 3.
[Drawing 6]It is a characteristic figure for explaining the variation in the terminal voltage (voltage at the time of discharge) of the cell group concerning this embodiment of the invention 3.
[Drawing 7]It is a figure for explaining operation of the rechargeable lithium-ion battery charging equipment concerning this embodiment of the invention 3.
[Description of Notations]
1, 11, 12 -- Cell group (two or more rechargeable lithium-ion batteries by which the series connection was carried out)
1-1 - 1-n -- Rechargeable lithium-ion battery (cell)
2, 20 -- The first charging equipment
3, 30 -- The second charging equipment
4 -- Load
5, 51, 52 -- Switching circuit
6, 60 -- Voltage probe
S, S1, S2 -- Switch
S-1 - S-n+1, S1-1 - S1-4, S2-1 - S2-4 -- Switch

[Translation done.]

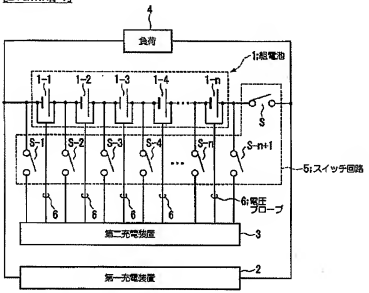
* NOTICES *



1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

## DRAWINGS

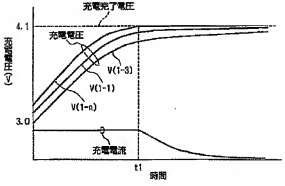
[Drawing 1]



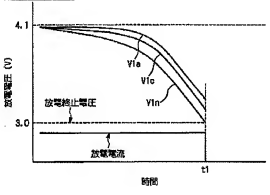

[Drawing 2]

| スイッチ | 第一充電装置による組電池定電流充電 | 第二充電装置による単セル定電流充電 | | | | | 第一充電装置による組電池フロート充電 |
|---|---|---|---|---|---|---|---|
| | | セル1-1 | セル1-2 | セル1-3 | ------- | セル1-n | |
| S | ON | OFF | OFF | OFF | ------- | OFF | ON |
| S-1 | OFF | ON | OFF | OFF | ------- | OFF | OFF |
| S-2 | OFF | ON | ON | OFF | ------- | OFF | OFF |
| S-3 | OFF | OFF | ON | ON | ------- | OFF | OFF |
| S-4 | OFF | OFF | OFF | ON | ------- | OFF | OFF |
| ≀ | ≀ | ≀ | ≀ | ≀ | ≀ | ≀ | ≀ |
| S-n | OFF | OFF | OFF | OFF | ------- | ON | OFF |
| S-n+1 | OFF | OFF | OFF | OFF | ------- | ON | OFF |

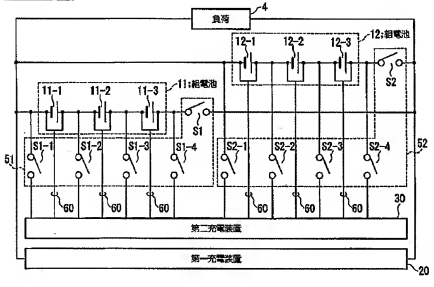
[Drawing 3]




[Drawing 6]

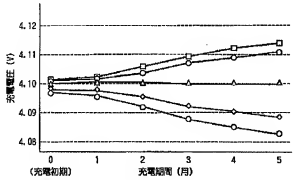



[Drawing 4]

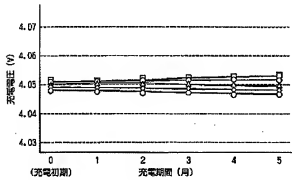



[Drawing 5]

(a)




(b)




[Drawing 7]

| モード | 回復充電モード | | フロート充電モード |
|---|---|---|---|
| | 第一充電装置による起電池定電流充電 | 第二充電装置による単セル定電流充電 | 第一充電装置による起電池フロート充電 |
| 第一充電装置 | ON | | |
| 第二充電装置 | OFF | ON | OFF |
| 充電装置出力電圧 | 第一の充電電圧 (第一充電装置および第二充電装置の出力電圧は同一の値) | | 第二の充電電圧 (第一充電装置) |

[Translation done.]